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ABSTRACT

This module is the second in a series of eleven modules in an energy conservation curriculum for secondary and postsecondary vocational students. It is designed for use by itself, to be integrated with the other ten modules into a program on energy conservation, or to be integrated into conventional vocational courses as a unit of instruction. The objective of this module is to train secondary and postsecondary students to recognize energy needs, energy consumption patterns, and conservation measures in several areas of use. First, an introduction to the module and definitions of key terms are provided. Next, the text is presented in the following four units: (1) residential/commercial energy use and conservation; (2) industrial energy use and conservation; (3) agricultural energy use and conservation; and (4) transportation energy use and conservation. The information in each unit is presented in lecture format accompanied by laboratory exercises and questions/examples for class discussion. A bibliography and several charts illustrating the text material are found at the end of the module. (BM)

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Energy Conservation Curriculum for Secondary and Post-Secondary Vocational Students. Module 2.

SURVEYING ENERGY USAGE

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CORSICANA, TEXAS

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MODULE #2

SURVEYING ENERGY USAGE

This module is one of a group of 11 modules in an energy conservation curriculum for secondary and post-secondary vocational students. It is intended for use by itself, integrated with the other 10 modules into a program on energy conservation, or integrated into conventional courses as a unit of instruction on SURVEYING ENERGY USAGE.

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MODULE #2

SURVEYING ENERGY USAGE

MODULE DESCRIPTION:

This module presents an overview of energy usage in the United States in each of four broad categories of use: residential and commercial, industrial, agricultural, and transportation. The importance of energy to each of these areas and their substantial reliance on energy for survival makes the student aware of the need for energy conservation in each of these areas. Problems related to conservation measures and proposed solutions are examined for practicality and adaptability.

GOAL STATEMENT:

The objective of this module is to train secondary and post-secondary students to recognize energy needs and energy consumption patterns in several areas of us. Further, the module prompts a search for conservation measures in each use area; such as, residential/commercial, industrial, agricultural, and transportation.

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MODULE #2

SURVEYING ENERGY USAGE

UNITS:

1. Residential/Commercial Energy Use and Conservation

   A. Household Needs
   B. Methods of Conservation
   C. Commercial Energy Use

2. Industrial Energy-Use and Conservation

   A. Industrial Energy-Conservation
   B. Energy Management
   C. Waste Heat Recovery
   D. Recycling

3. Agricultural Energy-Use and Conservation

4. Transportation: Energy Use and Conservation

   A. The Automobile
   B. Problems in Transportation

      1.) Regulations vs. Economy
      2.) Inter-city Travel
      3.) Commuter Problems

   C. Proposed Solutions

      1.) Conservation, Regulations, Driving Habits and Engine Changes
      2.) Alternatives to Fossil Fuels

         a.) Electricity
         b.) Other Combustion Fuels

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MODULE #2

SURVEYING ENERGY USAGE

TERMINOLOGY

air washer - a washer spray system or device for cleaning, humidifying, or dehumidifying the air.

appliance - an instrument or device designed for a particular use; a household or office device (as a stove, fan, or refrigerator) operated by gas or electric current.

British thermal unit (Btu) - a unit of heat energy equal to the heat needed to raise the temperature of 1 pound of air-free water from 60 to 61 F at a constant pressure of 1 standard atmosphere.

calorie - a unit of heat energy equal to the heat required to raise the temperature of 1 gram of water from 14.5 to 15.5 C at a constant pressure of 1 standard atmosphere.

energy - the capacity for doing work.

hydrogen gas - the first chemical element, symbol H, in the periodic table, atomic number 1; under ordinary conditions, it is a colorless, odorless, tasteless gas composed of diatomic molecules, H_2.

hydroponic gardening - raising plants in a liquid of nutrients instead of soil.

insulation - material that does not readily conduct heat energy.

megawatt - a unit of power, equal to 1,000,000 watts. abbreviated MW.

methane - a gas or combustible substance produced by converting waste products and animal feces.

phosphor - a substance that emits light when excited by radiation.

pyrolysis - chemical change brought about by the action of heat.

Quad - a unit of heat energy equal to 10 British thermal units.

R-value - the resistance of a material or an entire wall to the flow of heat. Insulation is rated in R values to show its resistance to heat flow. The higher the R-value the more resistance to heat the material is.

ton-mile - amount of energy it takes to move one ton of payload one mile.

vacuum gauge - a gauge indicating the degree of negative pressure.

MODULE #2
SURVEYING ENERGY USAGE

UNIT 1.
RESIDENTIAL/COMMERCIAL
ENERGY USE AND CONSERVATION

OBJECTIVES: Upon completion of this unit the student will be able to:

1. Understanding energy needs and uses in the U.S. household.

2. Discuss methods of energy conservation available to the homeowner, including insulation, weatherstripping, and general maintenance tips.

3. Recognize energy uses peculiar to the U.S. commercial sector and discuss conservation methods to improve energy consumption efficiency.

LECTURE

A. HOUSEHOLD NEEDS

Almost 20% of the energy used in the United States is used in seventy million households. By far the greatest amount of energy is used in heating and cooling our homes. Seventy-one percent of residential energy is used in space heating and cooling, 16% is used for heating water, and the remaining 13% goes into lighting and running various small appliances. Ninety- eight percent of the space and water heating is done through the burning of oil and natural gas. Most of the remaining 2% of space and water heating is accomplished with coal. Electricity accounts for an insignificant amount in this area. Electricity is the only significant energy source for cooling, lighting, and running small appliances in the residential sector. It should be noted, however, that about 80% of the electricity produced in this country is produced by fossil-fueled generators. Thus, residential energy almost totally depends on fossil fuels. When we consider that residential use accounts for about

LABORATORY

This unit is devoted to a discussion of energy use and conservation in the residential and commercial sectors. During this unit there should be samples of several different insulation materials available for the students to observe and handle; fiberglass batts of different thicknesses, loose fill material, rockwool (if available), cellulose insulation, and/or foamed-in-place material -- similar material is available in pressurized cans for demonstration purposes.

During this unit there might also be an ongoing demonstration experiment showing the actual value of insulating materials. Many different demonstrations might be devised. A simple, but effective one would be to take two identical containers (glass jars for instance) filled with equal amounts of hot water.

20% of the total energy used in this country, it becomes clear that this must be an area of concern. While schools, stores, hospitals, offices, and all other commercial (non-industrial) enterprises are also using energy in most of the same ways as residences, the energy use by this group of non-residential consumers amounts to only about 11% of the total energy used. Commercial consumers are generally more cost conscious (and, therefore, energy conscious) than residential consumers and also usually start from a base of more energy efficient contribution.

As energy costs have escalated, commercial consumers have been more willing to introduce lower heating and higher cooling temperatures and reduced lighting levels than the average residential consumer. There are more reasons than cost that have brought this about. The commercial user of energy is more exposed to social pressures to reduce energy use than the residential consumer. The "I'm a good person" syndrome works for the commercial consumer who proves daily to his customer that he is conserving energy. Who is to know when the residential consumer is doing his/her part? How much goodwill does a homeowner generate with a cooler house in winter and a warmer one in summer? A large commercial building ablaze with lights long after commercial activity has ceased clearly says that the owner is not concerned about the energy crisis and the owner quickly hears about it from consumers or clients. Who speaks to the homeowner whose house is ablaze with lights behind drawn shades?

B. METHODS OF CONSERVATION

Clearly, we must make the residential consumer aware that his/her 20% share of the energy use in this

One jar should be completely enclosed in insulating material (or several identical jars could be covered with different types of different amounts of insulating material) and one jar should be uninsulated. Temperatures of the water taken at the beginning, middle and end of the session should show a much smaller drop of temperature of the insulated jar(s). If an artificial wind can be created (a small electric fan would do this job) the results will be even more dramatic.

country is significant. One must realize that any contribution made through reduced comsumption in any way can make a significant impact on the nation's total energy use especially when multiplied by over 200 million residents.

About 40 million single family homes in the United States are inadequately protected from outside weather. In many cases, an investment in insulation would reduce the energy demand of heating and cooling equipment from between 10% up to 30%. In most cases, the price would be about the same as the price of a color television console. But the price will be recovered several times over the years through lower utility costs.

Current Federal Housing Administration regulations call for at least an R-19 value of insulation in attic floors or over top floor ceilings in new houses. This is a good general guide for older houses; however, in areas where temperatures are extremely low or high, higher R-values of insulation are desirable. (R-values are insulation efficiency ratings with higher R-values representing more effective insulating capabilities. Each different material varies in R-value according to thickness. While 6 to 6 1/2 inches of fiber glass batts or blankets have an R-19 rating, it takes 8 to 9 inches of loose fill fiberglass to have the same rating.)

At least 15 million single family homes have no attic or ceiling or top floor insulation. If insulation were added, there would be a savings of 8% of the total residential heating energy used each winter day. This not only amounts to equivalent of millions of gallons of oil each year, but also many dollars in savings to the residential consumer.

Another easily accomplished conservation method for the residential consumer is caulking and/or weather stripping doors and windows. Windows and doors can be tested for air-tightness by moving a lighted candle around the frames and sash edges. A Flickering flame is a clear indication of the need for attention to these areas. Will a quarter slide under a closed outside door? If so, weather stripping is called for. Properly installed combination storm windows are obviously desirable, but clear plastic film taped to the inside of window frames will also provide considerable savings. (However, it should be noted that using plastic increases the fire hazard.) Savings of up to ten percent per year in space heating costs can be realized through various use of these measures.

Space heating costs and energy consumption can also be reduced by lower living temperatures. For every degree the average temperature above 70 is reduced in a home, savings of from two to three percent are normal. Where temperatures are only reduced at night, the savings are about one percent for each degree of reduction. For most people with space heating costs in the $250-$700 per annum range, these savings may not seem sufficiently significant to bother with. The emphasis must be made, however, that the savings are not just in dollars but in gallons of oil or cubic feet of gas and when multiplied by 70 million households represents significant savings of irreplaceable resources.

Other residential conservation measurers that should be noted are:

1. A reduction of 10 degrees in hot water temperature can reduce energy use here by 6% and a reduction of

20 degrees may save 18% or more. Most hot water tanks are set for 140° water, but water at 120° is adequate for most families unless a dishwasher is used.

2. Use cold water, not hot, for household cleaning where possible.

3. Use a cold water setting for washing and/or rinsing clothes.

4. Use ventilating fans in bathroom and kitchen as little as possible. Most will exhaust a houseful of warmed or cooled air in an hour.

5. Reduce diswasher use. One less use per week for each diswasher in the country could save 9,000 barrels of oil daily.

6. Keep fireplace dampers closed when the fireplace is not being used. They vent the heated room air directly to the outside.

7. Close off unoccupied rooms and shut their heating or air conditioning vents.

8. Turn off lights when they are not needed and use low watt bulbs for porch lights, closets, television rooms and other areas where bright lights are not needed.

COMMERCIAL ENERGY USE:

In the commercial sector, businesses have made many efforts to conserve energy. Many businesses change their hours of operation to take advantage of daylight savings time. Some businesses close at 5:00 p.m. on week days and stay open Sunday to conserve the extra electricity required to operate until

Texas has "Blue Laws" which require commercial businesses to close on either Saturday or Sunday or restrict the selling of certain items on these days if they are open seven days a week. Could there be an argument for repealing Texas "Blue Laws" as an energy conservation measure?

9:00 or 9:30 p.m. each evening. Many businesses put an automatic regulator on the thermostat to keep the temperatures for heating and cooling at the minimum setting for maintaining comfort and conserving fuel. In many areas of the country, reflective film is applied to plate glass windows to reduce sunlight penetration and thus save on the cost of cooling buildings. Lights in parking lots are run by automatic timers and are turned off as soon as the stores close at night. Signs advertising businesses are seldom left on all night as they once were in many large cities. In some areas, every other street light is left dark in order to save energy.

City Planners take the energy conservation problem into consideration. New buildings are designed and constructed to conserve energy. Installing a minimum of windows and better insulation and duct work for air conditioning and heating are measures that have been taken as a result of careful planning. Double lobby doors have been installed in many large buildings to eliminate drafts and keep heat (or cool air) inside the buildings when people enter or leave. Conservation measures taken to date have been extensive, but there are still many areas of public domain where more effort could be expended. Lights should be turned off in public restrooms and lounge areas when no one is using the facilities. Office lights could be turned off during lunch hours. Many small measurers could add up to a large savings in energy.

The class could discuss at this point the areas they are familiar with at the college, city, and county level and decide if there are measures that should be taken that could result in saving energy. They might even become enthusiastic enough to undertake a project to educate their fellow students in this area. (A simple sign on each light switch, such as "When not in use, save the juice! - Please turn light off when leaving the room" might start their families on an energy saving binge!)

UNIT 2.

INDUSTRIAL ENERGY -- USE AND CONSERVATION

OBJECTIVES: Upon completion of this unit the student will be able to:

1. Recognize the use and consumption of energy in the industrial sector of the U.S.

2. Discuss the sources of industrial energy supply.

3. Discuss conservation measures available to industry through energy management.

4. Discuss conservation measures available to industry through waste heat recovery.

5. Discuss conservation measures available to industry through recycling.

LECTURE

The same forces which are reshaping our views and uses of energy in the residential/commercial areas are at work in the industrial/agricultural segment of our society.

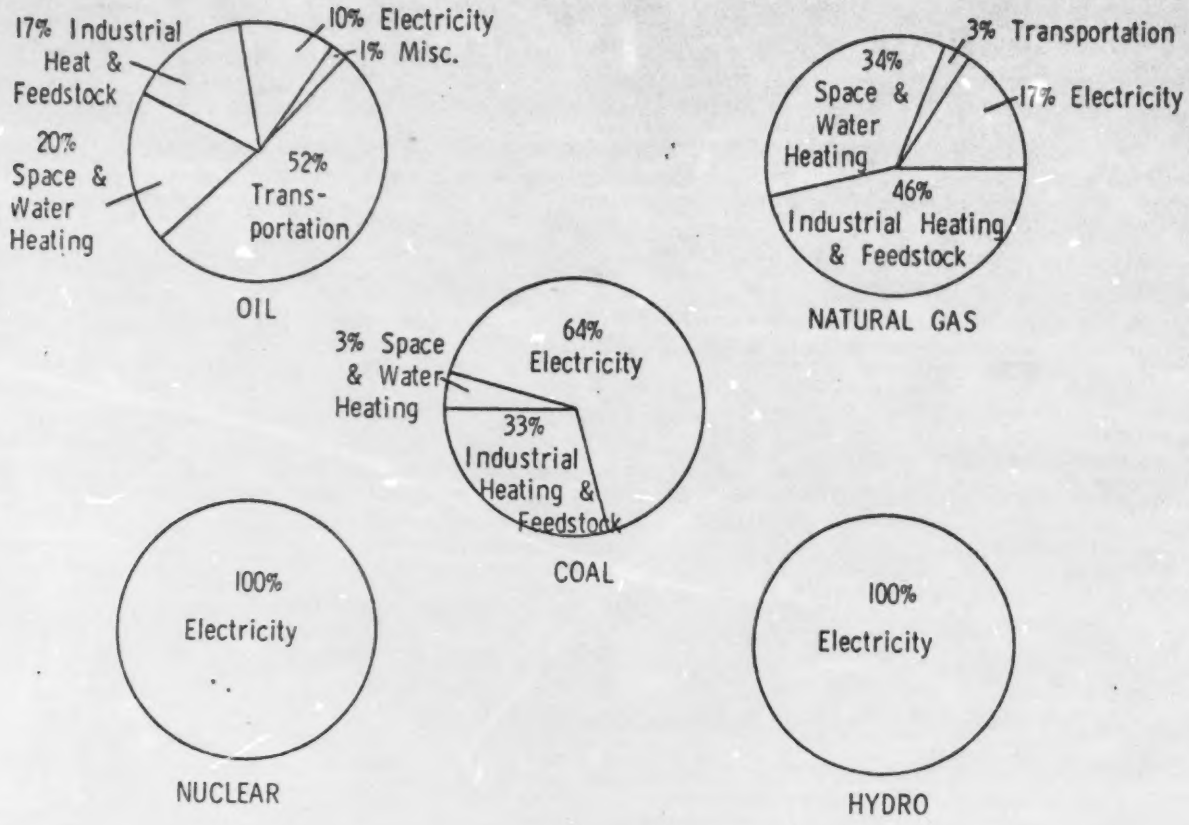
The modern industrial society consumes large amounts of energy. As fossil fuels inevitably run out hard decisions regarding allocations of dwindling supplies will have to be made. It is also possible to make considerable savings through various energy conservation measures in industrial/agricultural areas.

LABORATORY

Industrial consumption of energy now amounts to about 35 to 40 percent of the nation's total energy budget, with the higher value including the electricity purchased from utilities for driving various motors and for certain electrolytic processes. This is a far higher consumption than in any other segment of the economy, so savings made in this area are very significant. In just two areas of industrial energy use, direct heating and the production of steam, about 27% of the nation's energy is used. This is slightly more than is used in all forms of transportation. The primary uses of this energy are in production of metals (particularly iron, steel, aluminum, and copper), refining petroleum, and production of basic chemicals, textiles, food, glass, and concrete.

The source of this industrial energy is almost totally from the various fossil fuels; coal, petroleum, and natural gas. Slightly more than fifty percent of all the energy used by industry is provided by natural gas. Industry consumes about 50% of the natural gas, 20% of the petroleum and 35% of the coal used in the United States. (Figure 2.1.) It is important to note that while industry uses about 35% of the coal (with much of the remainder being used in the generation of electricity) this use of coal accounts for only 16 to 18 percent of the total energy used by industry. Most of the coal used today by industry is used in the production of primary metals, particularly steel. Just a few decades ago, coal was the primary fuel for industry, but competition from natural gas and petroleum products has resulted in a rapid decline in the use of coal. Difficulties associated with coal use have encouraged the use of natural gas and petroleum products. Coal creates more air pollution, requires larger storage facilities, and necessitates ash disposal methods. Moreover, coal use is more

HOW THE RESOURCES ARE USED



Courtesy: American Nuclear Society FIGURE 2.1

complicated in operation than gas or oil. These factors work against increased use of more available coal and encourage continued use of rapidly depleting oil and gas supplies.

The high dependence of industry on natural gas presents a major problem. As supplies become limited, industrial users will be forced to conserve and to switch to less desirable oil and coal. In the future the use of natural gas will likely be restricted to use as a raw material in certain areas and as a fuel only where an especially clean fuel is important. (In the electronics industry and in the direct heating of food products for example.) Though inevitable, the industrial

change away from natural gas to coal will be both slow and costly because of the changes that will be required in processing systems.

Some mention should be made here about the current switch to coal as boiler fuel for electric generators in many parts of the nation. Companies who would use coal as fuel sometimes face stiff opposition from environmentalists because of the fallout from the smoke stacks (even air scrubbers do not remove all the impurities and there is some pollution). This opposition and the cost factor in converting operations so that coal can be used discourage the change-over to coal.

The major use of petroleum by industry is in the production of chemicals. Forty-three percent of the total industrial use of petroleum is expended in the production of chemicals with the greatest amount of this petroleum used as raw material, not energy. Petroleum refining accounts for another 26% of industrial petroleum use, so, in just these two areas, 69% of industrial use and 12 to 14 percent of the total use of petroleum in this country is accounted for.

There are many ways that small and large industries can conserve energy. A conservation of 20% industrial energy today would represent an annual savings equal to the total annual energy consumption thirty years ago.

INDUSTRIAL ENERGY - CONSERVATION:

Figure 2.2 shows the major energy users in industry. Some of the methods that have been used or could be used to conserve energy are as follows: West Germany and other European nations have conserved vast quantities of energy through co-generation (discussed under Waste Heat Recovery).

MAJOR ENERGY USERS IN INDUSTRY

INDUSTRY GROUP	TOTAL ENERGY %	ELECTRICITY %
Primary Metals	21	23
Chemical & Allied Products	20	29
Petroleum Refining And Related Industries	11	4
Paper & Allied Products	5	5
Food & Kindred Products	5	6
Stone, Clay, Glass and Concrete Products	5	5
Totals	67% of Total Energy	72% of Total Electricity

ENERGY INTENSIVE INDIVIDUAL INDUSTRIES

INDUSTRY	SPECIFIC FUEL CONSUMPTION (million Btu/kg)	PERCENTAGE OF INDUSTRIAL SECTOR FUEL
Iron & Steel	29.1	15.2
Petroleum Refining	4.8	11.4
Paper & Paperboard*	27.0	5.4
Aluminum	170.5	2.8
Copper	28.4	0.4
Cement	8.7	2.5
Total	268.5	37.7% of total use

*Does not include heating value of waste products (bark and spent pulp liquor).

Source: NSTA Factsheet No. 10 "Energy Conservation-Industry" by John M. Fowler, 1977.

FIGURE 2.2

ENERGY MANGEMENT:

Several large commercial organizations (e.g. Dow Chemical, DuPont) now offer energy management advice to other companies. DuPont, for instance, decreased its BTU input per unit of product by 25 percent over the past decade and claims to have helped 91 other industries save $13 million in energy costs.

It is estimated that savings of 15 percent (without appreciable capital expenditures) are available immediately. With program redesign and some technological improvement, an additional 10 to 15 percent can be saved in the next 5 years and 10 to 20 percent more over the following 5 to 20 years.

WASTE HEAT RECOVERY:

Major accomplishments will most likely be in the area of utilization of presently wasted heat or more efficient combustion. Heat is a necessary ingredient for many industrial processes, but much of it is wasted or used inefficently. In the metals and glass industries, for example, significant amounts of energy are exhausted up the furnace stacks. The U.S. Department of Energy's Conservation Office estimated that 7 Q* BTU'S of high temperature heat energy is used for direct heating at an efficiency of only 20 percent. The heat in waste gases, cooling process water, and in hot stock may be retained, converted to steam, and utilized in a turbine drive that can either generate or substitute for electricity. It may become feasible to recover low temperature waste heat from industrial operations and use this for residential space and hot water heating. In Scandinavia, relatively low-temperature (60 C/140 F) waste heat from papermaking machines is collected and used for domestic purposes. This practice conserves their supply of high quality fuels for use other than in the residential sector. This conservation method could be applied in the United States where we often use high quality fuels for residential purposes.

"Co-generation," the simultaneous production of electric power and heat in industrial operations is a powerful energy conservation technique whose development has been slowed by economic and institutional barriers. It is estimated that the energy savings potential of co-generation could reach 2.1 Q* by the year 2000. Implementation of industrial co-generation will add more than 50,000 Mw of low cost generating capacity (more than the 1976 nuclear capacity) and reduce the need for utility expansion.

(* Q stands for Quad-10 British Thermal Units.)

Using waste heat to pre-heat combustion gases is one of the most practical conservation methods, and it is currently available. Most furnaces are supplied with air (necessary for combustion) at room temperature. If a furnace which discharges flue gases at a temperature of 2500°F is supplied with air preheated to 1000°F, there can be a savings of about 30 percent in fuel consumption. If the waste gases could be used to preheat the air to 1800°F, the savings in fuel could approach 45 percent.

Other obvious, relatively inexpensive, and still not always used methods of conserving industrial fuel are combustion control devices that insure efficient burning, careful application of good insulating materials to furnaces and boilers, and the elimination of unneccessary cold air leaks.

RECYCLING:

Figure 2.2 also suggests the conservation potential of recycling. Recycling could save 200 M (million) BTU's per ton of aluminum, 12 M BTU's per ton of steel, and 42 M BTU's per ton of copper. According to EPA, 60 to 75 percent of aluminum used in this country could be re cycled (4 percent is presently) and 90 percent of the steel (1.4 percent is at present).

A large percentage of solid waste is paper; if recycled, it requires only about one quarter the energy of virgin wood pulp. Although the amount of recycled paper used in the paper industry has decreased from 35 percent of the 1944 total to only about 20 percent now, its use is showing signs of growth. There are now several mills producing paper from waste paper and its use--and energy savings--is increasing.

Other valuable materials are wasted. Much of the waste from plastic manufacture has fuel value. Carbon monoxide is discharged in large quantities by several basic industries (e.g., iron smelting, aluminum and phosphorous production). The feasibility of using this as a raw material for plastic manufacture is under investigation.

A specific example of recycling which shows the savings that can be obtained is in the "coil coating industry" which produces painted steel coils for appliance manufacture. Past practice has been to spray paint the coils and dry them in a natural gas-fired oven. In one experiment, paint solvents, which normally go up the stack as pollutants are recaptured and burned to provide heat for the drying ovens. The use of natural gas in this plant was reduced by two-thirds.

MODULE #2

SURVEYING ENERGY USAGE

UNIT 3.

AGRICULTURAL ENERGY --
USE AND CONSERVATION

OBJECTIVES: Upon completion of this unit the student will be able to:

1. Appreciate the sources and amount of energy required to produce food and services through agriculture.

2. Understand the importance of agriculture in the U.S. being "energy intensive" and the influence it has had on this field.

3. Recognize the correlation between number of people fed and the amount of land and energy required per capita.

LECTURE

LABORATORY

In any discussion of agricultural energy use and conservation, one point should be strongly emphasized: as it is practiced in the United States today, agriculture is energy intensive, not labor intensive. Machines of all sorts, powered by diesel or gasoline engines, have replaced both manpower and animal power on the farm. It has only been through this substitution of fossil fuel energy for man and animal power that the American farmer has been able not only to provide us with probably the best (and certainly the most varied) diet in the world, but also to produce a surplus of some commodities for export to other areas of the world.

This surplus is not, and never will be, sufficient to feed the entire world. Most people in the world today do not receive an

adequate amount of food containing the proper distribution of proteins, carbohydrates and fats. As the energy crisis worsens, persons in the emerging, but still underdeveloped nations see continued inadequate food supply as a major problem. A significant difficulty is the shortage of fertilizer which, properly applied, is very important in achieving high crop yields. The production of fertilizer, however, requires energy that is in short supply in all underdeveloped nations. This shortage of energy also means less energy to manufacture farm machinery and less energy to run the machinery if it is manufactured.

The total amount of energy used directly in agriculture is not of great significance in our total energy budget. Food, however, is essential, and agriculture gives a good example in the energy field of the ecological adage that "everything is connected to everything else."

The agricultural energy budget is certainly part of the industrial energy budget. Manufacturing chemical fertilizers and manufacturing concrete and steel used in dams to impound water for irrigation purposes are but two obvious examples. All the processing and packaging of food also comes under the industrial energy budget.

The transportation energy budget involves moving materials both to the farm and away from the farm. There is still more interconnection with the commercial energy budget as most of the food eventually reaches the public through stores and supermarkets. Could the population of this country (225 million plus) be fed today with the agricultural practices of 100 or even 50 years ago? If it had to be, how much would we have to eat, what would it likely be, and what would happen to the cost?

It might be useful to select some items of diet (hamburger, for example) and briefly trace the energy inputs before this appears in the kitchen or is purchased at the local hamburger stand.

Early agriculture was a boon to mankind because one man could produce more calories of food value than the calories of energy he expended. With moderately advanced agriculture methods using animal power the sum of man and animal energy was still exceeded by the caloric energy of the produced food. Today, for many high profit but low energy crops (such as melons, tomatoes, onions and other low calorie fruits and vegetables that require spraying, fertilizing and cultivation to produce a good crop), far more calories of fossil fuel energy are consumed in producing that crop than there are calories of food energy in the crop produced. Whenever this occurs, we must recognize that we are wasting energy in just as serious a fashion as when letting useful heat go up the chimney.

There are a number of ways in which energy conservation can be achieved, but every barrel of oil or its equivalent saved is important. If some is good, more may not be better, and over-fertilizing fields is a waste of energy. Maintaining efficient operation of farm machinery is as important as good maintenance of an auto engine for fuel economy. Far more use should be made of organic fertilizers. Manure from feed lots and from chicken and turkey farms is often considered only a problem to be disposed of rather than a useful by-product.

A discussion of agricultural energy problems provides an opportunity to introduce the effects of increasing population on the energy problem. If our population

grows by only 1/2 of 1% (.5%) per year, we will add just over 1,125,000 new persons annually. When these people take their places at the nation's dinner tables, if they are to enjoy the same diet that we have enjoyed, farmers will have to plant another 5,000 acres of potatoes, 3,000 acres of tomatoes and 2600 acres of oranges. (Figure 3.1 shows these statistics). They also must raise hay and grain and provide pasture for 130,000 additional beef cattle and over 80,000 dairy cows. And, when that additional 1,125,000 people want to have turkey for Thanksgiving, they will require about 200,000 more birds. Each of these items and all the other agricultural items that go into our diet require energy. If we are going to have the energy available to provide not only our food, but necessities, we must both conserve in all possible ways and simultaneously increase our research and development of alternate energy sources and more efficient use of fossil fuels.

IMPACT OF POPULATION GROWTH
ON AGRICULTURAL PRODUCTION

For each 1¼ million new persons added to our population farmers must plant or raise an additional:

5000 acres of potatoes

3000 acres of tomatoes

2600 acres of oranges

hay, grain, and pasture for 130,000 beef cattle and 80,000 dairy cows

200,000 Thanksgiving turkeys

or at least increase production by an equivalent amount.

The increased energy consumption to produce these increased amounts of food will reduce the number of years that our energy supplies will last.

Source: The Squeeze, Edward Higbee
William Morrow & Company
New York, NY 1960
Lib. of Cong. #60-14496
(U.S. Dept. of Agriculture)

FIGURE 3.1

UNIT 4.

TRANSPORTATION: ENERGY USE AND CONSERVATION

OBJECTIVES: Upon completion of this unit the student will be able to:

1. Recognize the importance of transportation to the economy of any nation.

2. Discuss the amount of the nation's energy budget which goes for transportation.

3. Appreciate the energy consumption of the automobile versus car pooling and public transportation.

4. Recognize and discuss problems associated with energy conservation measures in transportation.

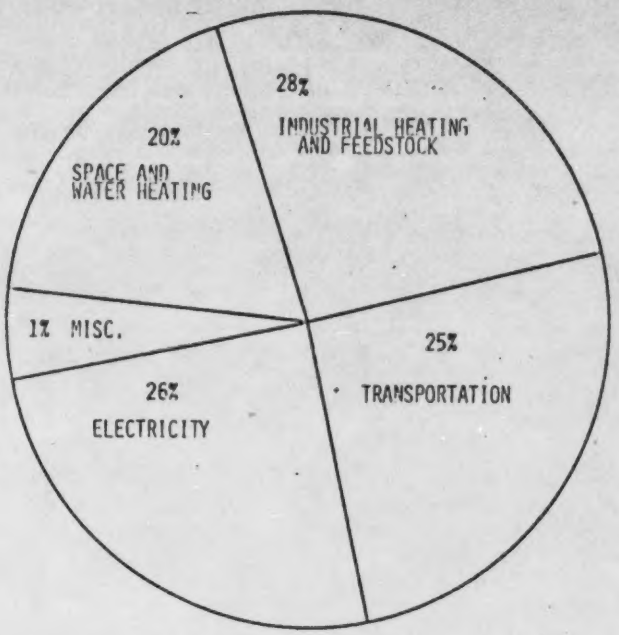
5. Be aware of proposed solutions for making transportation in the U.S. more energy efficient.

6. Discuss alternate fuel solutions to fossil fuels for use in transportation.

LECTURE

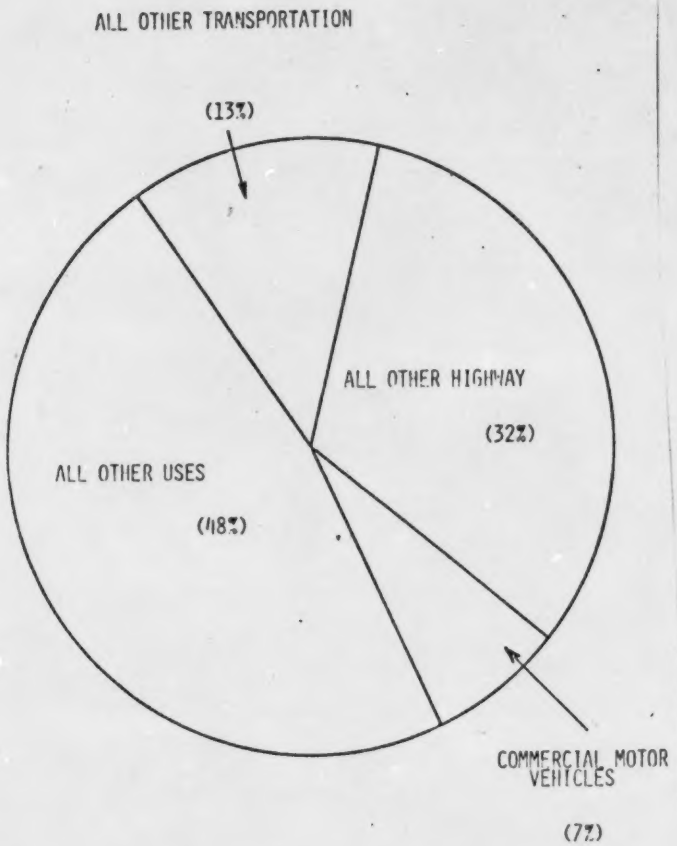
LABORATORY

The transportation segment of the economy of the United States currently consumes about 25 percent of the nation's energy budget. About 77 percent of the transportation energy (or about 20 percent of our total energy) is used by highway vehicles. Commercial and industrial trucks and buses use about 20 percent of the energy and private automobiles consume most of the remaining 57 percent. In terms of the nation's total energy budget, some 15 percent is used to power private vehicles. (Figures 4.1 and 4.2)



DISTRIBUTION OF ENERGY USE

FIGURE 4.1



TOTAL U.S. PETROLEUM CONSUMPTION - 1973

FIGURE 4.2

Trains, boats of various types, and planes account for about 23 percent of the transportation energy or about 6 percent of the total energy budget of the nation. In the case of trains and boats, the largest amounts of energy are used in transporting both high bulk and high weight raw materials and finished products. Though we normally think of planes in terms of the transportation of people, freight transport is also significant, particularly where the necessity of speed, perishability of cargo, and light weight or high value shipments are involved. The fact that these types of transportation consume only 23 percent of the transportation energy budget suggests that most discussion should concentrate on both use and conservation of energy in the highway transportation segment.

There are several distinct areas of highway transportation, each with its own energy demand and with varying conservation possibilities. Private and commercial industrial vehicles play different roles in the economy and, likewise, in any discussion of energy. Where and how these vehicles are being used is also significant and must be considered in any energy plan.

THE AUTOMOBILE:

Private automobile use consumes 15 percent of the nation's energy budget and the vast majority of individuals are personally responsible for at least some small part of that use. It seems unlikely that the American public will be separated from the private automobile. The private car is an integral part of our life style and of the economy. What may have to change is the way in which the private automobile is used. In Boston for five to six days following the great blizzard of February 6-7, 1978, no private

vehicles were permitted on roadways within about 15 miles of the city. More public transportation was made available, work hours were staggered, and the public coped. Most people walked more in four days than they normally do in a month and their health was not harmed. Once private travel was again permitted, however, cars appeared like ants from an ant hill and public transit service was reduced.

In most large cities public transit has deteriorated since 1950 as more automobiles have come into use. Freeways and toll roads have used former commuter rail rights-of-way and parking lots and garages have proliferated. Traffic congestion is an accepted part of life. Can limits be imposed on the use of private cars? Can we ban them from certain roadways at certain times? Can we require a higher occupancy rate during certain hours? Will we have to impose limits of these or other types? These kinds of questions should provide some heated but potentially useful discussion.

It might be well to note that our freedom is already limited in certain ways. Traffic lights and speed limits, stop signs and no parking zones are limits to our freedom to do as we please when such "doing" would be harmful to ourselves and others. Water restrictions are common in areas of restricted supply. Should we expect less in the area of transportation as the energy crisis worsens?

Van pooling is being tried in a few major cities. During peak hours, of traffic are reserved for those commuters involved in a van pool. Van pooling and car pooling are less difficult to arrange if places of employment provide a system of matching riders and locations.

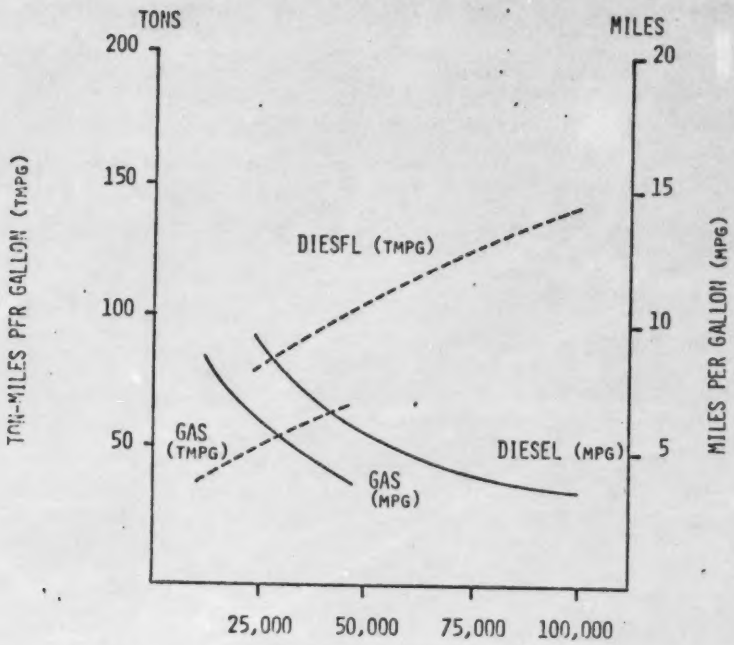
The movement of people occurs in many varied situations--commuting to and from places of employment, general travel within a city or suburban area, travel between cities, and vacation travel, to name a few. To illustrate this idea, ask the students to list all the different purposes for which they traveled during the past week and the method by which the travel was accomplished (example: went to doctor--car; went to work five times--bus; picked up a quart of milk--walked). A quick compilation on the blackboard will show the many different kinds of movements people make. A similar situation exists for the movement of goods. There are vast differences in transportation and energy problems associated with in-town delivery trucks, oil delivery trucks, and freight carriers in inter-city or cross continent delivery.

Some of the major cities and some rural areas are trying out the use of mini-buses for use by senior citizens to commute to shopping plazas and doctor's offices. Churches and private organizations are attempting to alleviate the transportation problem by running their own buses. Many large hotels in tourist areas are furnishing bus transportation from the airport to the motel and from the motel to nearby attractions for a nominal fee.

REGULATIONS VS. ECONOMY

Often, regulations are passed that control many parts of the transportation industry and the effect may be both positive and negative. The nationwide 55 m.p.h. speed limit can be discussed as an example of this. There is no question that a 55 m.p.h. (or even 50 m.p.h.) speed limit on automobiles, small trucks, and vans results in considerable savings of energy. The standard car engine will produce 3-5 more miles per gallon at 50 m.p.h. than it will at 70 m.p.h.--a fairly common travel speed when limits were 65 m.p.h. Large tractor trailer trucks, however, may achieve no economy at the lower speed and will probably achieve fewer ton-miles per gallon of fuel used. Ton miles are a much better measure of economy for heavy freight transport than simply miles per gallon. Energy per ton mile is the amount of energy (usually derived from fossil fuel) it takes to move a ton of payload one mile. In figuring overall economy per ton mile, men and equipment are considered as well as fuel costs. (See figure 4.3) Economic energy consumption on heavy diesel trucks is usually greatest when steady speeds can be maintained and down-shifting and acceleration are

APPROXIMATE PRODUCTIVITY IN TON-MILES PER GALLON
VS. FUEL ECONOMY IN MILES PER GALLON



UNLIKE PRIVATE PASSENGER VEHICLES, LARGER VEHICLES (EITHER GASOLINE OR DIESEL POWERED) PRODUCE MORE EFFICIENT TRANSPORT IN TON MILES PER GALLON AT WHAT APPEARS TO BE A LESS ECONOMICAL MILES PER GALLON FUEL CONSUMPTION.

A TON MILER PER GALLON IS THE NUMBER OF TONS THAT CAN BE HAULED ONE MILE ON A GALLON OF FUEL.

FIGURE 4.3

kept at a minimum. In many areas of the country a 55 m.p.h. speed limit forces gear changing and loss of economy. Should trucks be allowed a higher speed limit than cars if a higher limit is more economical? Should special lanes be set aside for truck use? What safety problems could exist if large, heavy trucks were continually passing much slower moving automobiles? Is it fair to have different speed limits for different kinds of vehicles?

Generally speaking, water transportation is the most efficient per ton mile; rail transportation is second. Highway transportation is the most common, but ranks third in efficiency while air freight is the least efficient per ton mile. However, one must take into account the urgency and availability of alternate methods of transportation. Transportation by water is quite slow and the waterways are limited. Railroads and highways have limitations also, whereas air transportation is used universally and has many advantages in regard to delivery. Materials may be transported to remote areas and parachuted to depots on the ground. It might take men and trucks many days to make the same delivery. Whenever practical, industry uses the most economical ton mile transportation to move raw materials and products.

INTER-CITY TRAVEL

Inter-city travel in the North-east corridor between Boston, New York, and Washington provides another example of transportation problems. Should most of this travel be by plane or should more of it be by rail? Trains can generally carry people at less energy cost per mile than planes, particularly for distances of 200 to 300 miles. Planes are faster, but trains go from central city to central city and eliminate trips to and from air-ports. During the past twenty-five years, while toll and inter-state highways have been constructed between Boston and New York and new and improved facilities made avail-able at airports in each city, little or nothing has been done to improve rail transportation. Today, the rail time between Boston and New York is the same 4-5 hours that it was in 1950, but high speed (150 m.p.h. plus) trains operate in Japan and in other countries. We must also ask how many choices of depar-ture and arrival times are really needed between cities. Would less

frequent service really be detrimental if the result were higher load factors and more economical use of energy? (Urban participants should be urged to find out the frequency of service by bus, plane, and rail into and out of their city relative to other cities 50-300 miles distant. Consumer use at different times of the day should also be determined, if possible.)

COMMUTER PROBLEMS

One of the most complicated problems and one which today is perhaps most wasteful of energy is the movement of people to and from work --the commuter problem. Though the automobile is widely used for this purpose, clearly such a system is not ideal. Traffic jams, frayed nerves, and numerous "fender bender" accidents are evidence that the system is not effective. The use of aerial patrols reporting the best or worst road conditions over radio stations in almost every city is further evidence that automobile commuting is inefficient. Studies carried out in the past few years indicate that commuting by automobile generally consumes about three times as much energy per-passenger-mile as is required for public transit. In more widely dispersed suburban areas where population densities would not permit effective public transit, transportation by automobile to a suburban transit stop and completion of travel by public transit could result in about 50 per cent savings in energy rather than a 66 percent savings for a total public transit ride. Clearly, a variety of efforts will have to be made to improve energy use in the many aspects of the transportation industry. Discuss efforts being made in your community.

PROPOSED SOLUTIONS

There are a number of significant steps that can be taken by almost everyone to aid in the conservation of energy in the area of transportation. Since the movement of people consumes most of the energy expended for transportation, it is here that the greatest conservation efforts should be placed. Since it seems unlikely that it will be possible to separate the consumer from the automobile, a strenuous effort must be made to improve the driving habits of motorists. While professional drivers in "economy runs" often get 50% more miles per gallon than the average driver, almost every driver could reduce his fuel consumption by 10 to 20 percent with no reduction in miles traveled. Two steps may be taken to accomplish much of this fuel saving: keep the vehicle properly maintained and practice good driving habits.

CONSERVATION, REGULATIONS, DRIVING HABITS AND ENGINE CHANGES

Changing the driving habits of millions of motorists will not be easy. Participants in this course, however, can prove to themselves that energy can be saved in this manner. While it is important to accelerate to high gear briskly, "jack rabbit" starts can cost as much as 50 percent more fuel. Think in terms of having an apple on the hood and accelerate in a manner that would keep the apple on the hood. Rushing ahead at stop lights often results in forced stops at the next light, thus wasting fuel in "jack rabbit" starts and losing momentum by having to brake at the next light. The lighter the foot on the gas pedal, the better the fuel economy.

In highway driving, when travel speed is reached, ease off the accelerator. A steady speed is much more fuel efficient than one that fluctuates. EPA tests show that

cruise controls on passenger cars conserve fuel. One of the worst highway driving habits is tailgating. Tailgating is not only dangerous but, in most cases, costs fuel in that it forces you to drive with the same habits as the person in front. With adequate space between vehicles, gradual speed adjustments can be made. When approaching a hill, gather momentum so that the hill can be climbed without undue pressue on the accelerator; when descending take pressure off the accelerator slightly to take advantage of gravity. In driving where there are traffic lights, anticipate the lights and slow down long before reaching a red light.

Left foot braking is costly to the consumer. Most people who brake with their left foot keep it there most of the time, especially while driving in traffic. Even a slight pressure on the brake while the other foot is on the accelerator puts added strain on the engine with consequent loss in efficiency. (Suggest to the participants that they observe how frequently they see brake lights on the car in front of them when braking is clearly unnecessary and obviously not being done to slow the car.)

A very effective way of conserving gasoline is to install a vacuum gauge and drive at a steady speed. A vacuum gauge will tell you immediately when you are over accelerating. One can be purchased for as little as $4 and is quite simple to install.

Gas mileage increases from good driving habits can easily be translated into dollar savings. For some drivers this could be as much as $100 per year. More importantly, even a 10-15 percent reduction in gasoline consumption by private vehicles would save about 3 percent of the nation's total energy budget with no significant reduction in miles driven.

Efforts are being made in many directions to improve the efficiency of vehicles. One of these efforts, strictly in the experimental phase, is flywheel energy storage illustrated in figure 5. The principle has been applied to some subsidiary electric transit vehicles and is being investigated for application to electric transit buses and delivery vehicles. Electric vehicles used primarily in urban traffic waste large amounts of energy by making frequent stops. During normal braking much of the "stopping energy" is dissipated as heat. This braking energy can be converted into flywheel energy. The flywheel energy is then used for acceleration or converted into electrical energy, stored and used for later acceleration. Considerable fuel savings should be obtained when this flywheel energy storage system is perfected. However, there might be a loss in net energy when one considers the extra material that must be manufactured to install the equipment.

Diesel engine developments are providing a new and more frequently used power source for small vehicles such as light trucks, vans and passenger cars. Though the initial cost is higher, it is felt that this cost is more than returned in lower fuel costs with an overall saving in energy.

The current EPA mileage ratings of vehicles and the use of these ratings in advertising indicate that more economical vehicles can be produced and that economy is of concern to many people. In most cases, the concern is only with the dollar cost of fuel not the consumption in gallons. Whatever the motivation, the effect is the same.

ALTERNATIVES TO FOSSIL FUEL

What of the future? All predictions indicate a real shortage of petroleum fuels within 20 years at present consumption rates. Conservation in all areas may extend the run-out time slightly, but not significantly. Thus, there appears at present to be only a single long-range solution to the transportation problem--a new method of propulsion that eliminates the almost total current dependence on fossil fuels.

In the 1970's the competitive advantage of the internal combustion engine (ICE) began to reverse. Gasoline costs began to climb and new laws on motor vehicle pollution and safety and fuel economy curtailed ICE vehicle performance capabilities, increased costs, and influenced vehicle markets to consider alternative forms of motor vehicle transportation.

ELECTRICITY

One possible alternative is the electric motor. This is already in use in certain specialized vehicles such as small lift trucks used in warehouses and in a few urban vehicles that cover only 20 to 40 miles per day at relatively low speeds. The major problems with widespread use of electric vehicles providing an adequate and compact storage system for electrical power on board the vehicle, locating sources of electricity other than fossil fuel to recharge the batteries, and establishing locations for recharging stations. Our current technology of battery storage is not efficient for most operations. The weight and bulk of batteries required for most vehicular operations today make the vehicles quite inefficient. New battery technology may solve this problem in the future.

In September 1976, the Congress enacted Public Law 94-413, the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976, to establish a program to stimulate the commercialization of electric and hybrid vehicles as a partial solution to the oil consumption problem. This Law, later amended by Public Law 95-238, reflects the seriousness with which Congress views our increasing dependence on foreign oil for transportation. The U.S. Department of Energy is supporting extensive research to develop the electric vehicle. Several thousand vehicles are being built under this congressional act which will provide for wide scale testing and identification of suitable markets. While it is recognized that at the present state of the art the electric vehicle has limited use, it could now be used on predictable routes and for businessmen to travel to and from commuter points. The goal is to start the process of establishing an industry so that we can have an efficient electric vehicle ready for use at such time as the conventional internal combustion engine cannot meet all of our transportation needs because of shortage of gasoline or other oil products. It is not expected that in the near future there will be any substantial savings in net energy, but that the electric vehicle will provide for a more flexible source of energy for transportation.

One nation currently taking advantage of electric power for its transportation needs is the Island of Taiwan. Taiwan has an abundance of hydro-electric power and is developing nuclear power. As a result, almost 100 percent of the rail transportation has been electrified.

Though it may appear that changing from petroleum fuel to electric power--still largely produced by fossil fuel generation--would not solve any problems, we must recognize that there are many

alternative sources of energy for the production of electricity. Hydro and nuclear energy are, of course, in use today along with fossil fuel electrical generating plants. Anything that burns could be used in place of the fossil fuel now used in steam generating plants. Slash from forest operations and urban and industrial wastes are two obvious sources of energy. In Nashville, Tennessee, a plant which burns municipal waste provides both heat and electricity for government as well as some private buildings. Electricity can also be generated via other energy sources. Wind and tidal power are already in use on a small scale and could certainly be expanded. Ocean temperature differences can be used to generate electrical current (OTEC), and it may not be out of the question, twenty-five years from now, to find that our electrical power is generated in space from large solar panels and beamed to earth via lasers. The important thing is that there are many sources for electricity other than fossil fuels, and if the storage problem can be solved, then a viable alternative to the internal combustion engine fueled with fossil fuel would be available.

OTHER COMBUSTION FUELS

Another approach to the problem of what to do when the oil runs out is to develop a different fuel for essentially the same type of internal combustion engine. Both methane gas and alcohol are fuels that have already been used for powering vehicles. Both can also be manufactured from organic sources other than the fossil fuels. Both of these fuels also suffer from some of the same problems of pollutant production that are associated with the fossil fuels.

Still another potential fuel for powering the internal combustion engine is hydrogen gas. With the exception of space vehicles, most hydrogen burning engines have been experimental. As with other fuels, problems exist that would have to be overcome. There is a problem of explosion and/or fire, but these problems also exist with gasoline or alcohol and methane. The problem may be greater, but it is still also open to solution. Another problem would be the manufacturing of large quantities of hydrogen gas. Currently, such production would most likely be done by breaking down the water molecule (H_2O) using electrical energy. Clearly, the great amount of electricity necessary would have to be provided by nonfossil fuel sources.

One distinct advantage of hydrogen fuel would be the virtual elimination of the air pollutants produced by fossil-fueled, internal combustion engines. The major product produced when hydrogen is burned is water vapor. Though on cool days we might see a small plume of condensed vapor extending from the exhaust of each vehicle, this vapor would certainly be preferable to the pollutants now produced by vehicles in our urban areas.

Methane is also a gas that has potential as fuel. It is clean burning, but has a relatively low btu production. The Japanese and Germans used it as fuel in World War II. We are looking at it in the United States because it is often a by-product of organic decomposition. Through a process known as pyrolysis, methane is produced in several modern solid waste disposal plants. It is then sold or burned to generate electricity.

Several inventors have developed novel vehicles powered by methane generated from animal feces. The generator is usually in the trunk of the vehicle. While the feces generated methane vehicle is little more than a fad, methane powered engines have been used in oil fields for years. It takes few mechanical changes to convert gasoline engines into gas engines. Since natural gas is in short supply, methane will not become a widely used fuel unless large quantities are produced through pyrolysis or some other bioconversion method.

The instructor has a unique opportunity in this module to introduce the students to many of the more interesting technical developments that have come about in response to our changing energy resources. Some of the developments that could be discussed in connection with energy conservation are; solar heating, underground and semi-underground residences, hydroponic gardening (gardening without soil, feeding the plants with a liquid solution of nutrients), solar greenhouses, ocean thermal power, wind power, magnetic and vacuum rail travel, enclosed and underground cities, methane powered automobiles, other methane uses, tidal power, energy from waste, and many more.

MODULE #2
SURVEYING ENERGY USAGE

BIBLIOGRAPHY

Bander, J. et. al. Energy Conservation In Buildings: New Roles For Cities and Citizens Groups, Washington, National League of Cities, 1975.

Cowart, I.C. Farm Electricity, Louisiana State Department of Education, Baton Rouge, Louisiana.

Dollars and Cents of Residential Energy Utilization: A Developmental Guide, Cooperative Science Educational Center, Oak Ridge, Tenn., 1972.

Energy Conservation in the Home, Lane Publishing Company, Menlo Park, California.

Fowler, John M. "Energy Conservation-Industry", Fact Sheet, National Science Teachers Association, No. 10, 1977.

Fraize, W.E. U.S. Transportation: Some Energy and Environental Consideration, National Technical Information Service, Springfield, Virginia, 1972.

Higbee, Edward. The Squeeze, William Morrow and Company, New York, New York, 1960.

How To Save Money On Home Energy Costs, Secretary of Consumer Affairs, Commonwealth of Massachusetts, Michael S. Dukakis, Governor, (pamphlet).

Industry Efforts In Energy Conservation, Commerce Committee Publications, 93rd Congress, 2d sess., Washington, U.S. Government Pring Office, 1974.

Innovation in Public Transportation, U.S. Department of Transportation, Urban Mass Transportation Authority.

Jones, Kenneth C. Ecolibrium, An Energy Information System, Vol. 6, No. 2, Spring 1977.

Lapedes, Daniel S. Energy: McGraw-Hill Dictionary of Physics and Mathematics, McGraw-Hill Book Company, New York, 1978.

Macrakis, Michael S. Energy: Demand, Conservation and Institutional Problems, Cambridge, MA M. I. T. Press, 1974.

Meier, Richard L. Planning for An Urban World: The Design of Resource-Conserving Cities, Cambridge, MA M. I. T. Press, 1974.

Priest, Joseph, Energy For A Technological Society: Principles, Problems, Alternatives, Reading, MA, Addison-Wesley Publishing Company, 1975.

Saving Energy: On The Road, United States Department of the Interior, Washington, DC.

Sikorsky, Bob. Every Drivers' Guide to More Miles Per Gallon, Mr. Mileage, P.O. Box 4800-H, Tucson, Arizona 85717, 1976.

Spies, Henry R. et. al. 350 Ways to Save Energy (and Money) in Your Home and Car, Crown Publishers, New York, 1974.

Stambler, I. Automobile Engines of Today and Tomorrow, Grossett and Dunlap, New York, New York, 1972.

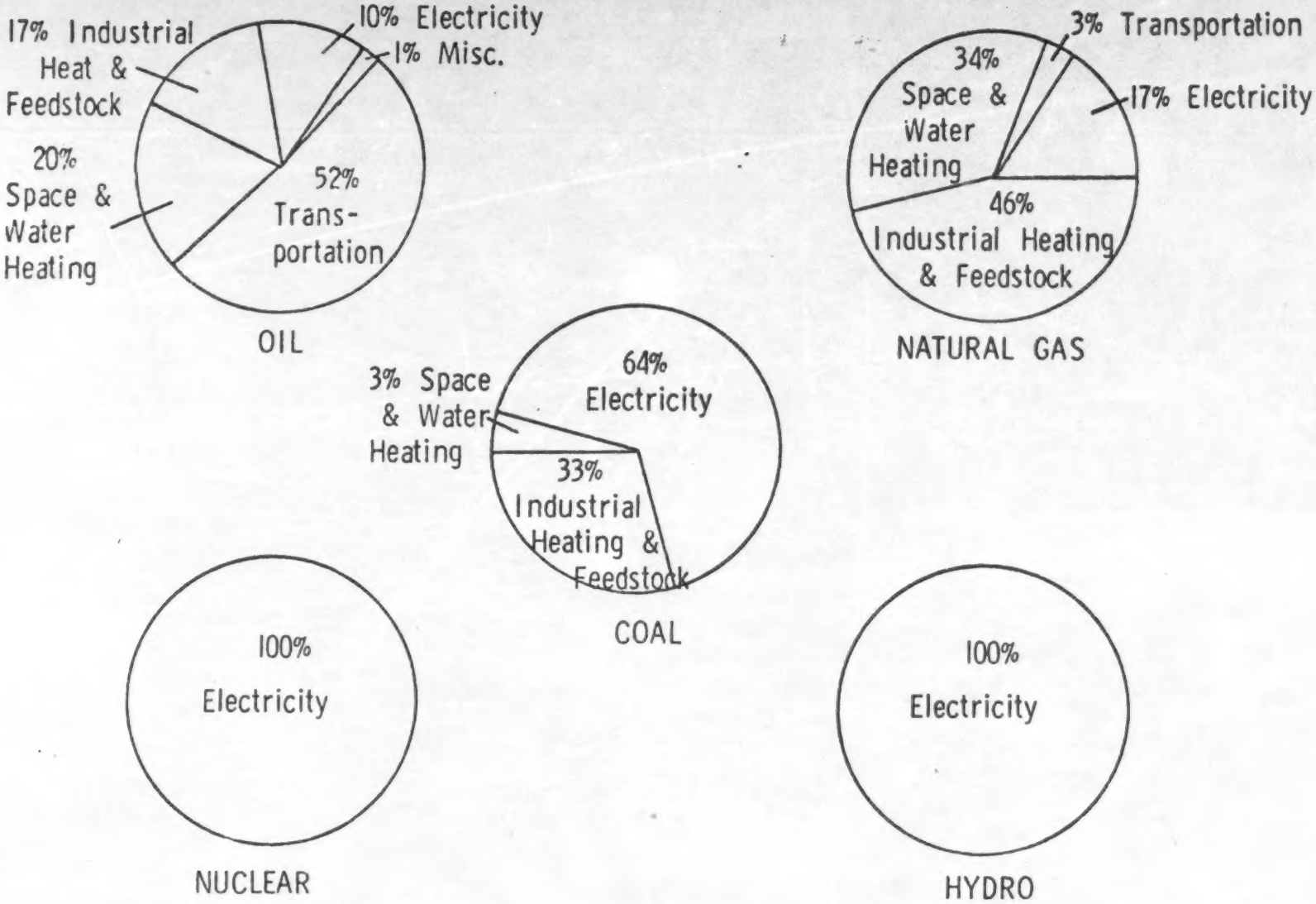
Tips for Energy Savers, Department of Energy, Conservation and Environment, Washington, DC, May 1977.

"Two Electric Cars," Consumers Report, October 1975.

U.S. Department of Energy, Public Law 94-413, The Electric & Hybrid Vehicle Research, Development & Demonstration Act of 1976, (DOE/CX-002/1).

Why An Energy Crisis? Department of Energy, Washington, DC, (FEA/A-75/292R).

HOW THE RESOURCES ARE USED



Courtesy: American Nuclear Society

FIGURE 2.1

MAJOR ENERGY USERS IN INDUSTRY

INDUSTRY GROUP	TOTAL ENERGY %	ELECTRICITY %
Primary Metals	21	23
Chemical & Allied Products	20	29
Petroleum Refining And Related Industries	11	4
Paper & Allied Products	5	5
Food & Kindred Products	5	6
Stone, Clay, Glass and Concrete Products	5	5
Totals	67% of Total Energy	72% of Total Electricity

ENERGY INTENSIVE INDIVIDUAL INDUSTRIES

INDUSTRY	SPECIFIC FUEL CONSUMPTION (million Btu/kg)	PERCENTAGE OF INDUSTRIAL SECTOR FUEL
Iron & Steel	29.1	15.2
Petroleum Refining	4.8	11.4
Paper & Paperboard*	27.0	5.4
Aluminum	170.5	2.8
Copper	28.4	0.4
Cement	8.7	2.5
Total	268.5	37.7% of total use

*Does not include heating value of waste products (bark and spent pulp liquor).

Source: NSTA Factsheet No. 10 "Energy Conservation in Industry" by John M. Fowler, 1977.

FIGURE 2.2
B

IMPACT OF POPULATION GROWTH ON AGRICULTURAL PRODUCTION

For each 1½ million new persons added to our population farmers must plant or raise an additional:

5000 acres of potatoes

3000 acres of tomatoes

2600 acres of oranges

hay, grain, and pasture for 130,000 beef cattle and 80,000 dairy cows

200,000 Thanksgiving turkeys

or at least increase production by an equivalent amount.

The increased energy consumption to produce these increased amounts of food will reduce the number of years that our energy supplies will last.

Source: The Squeeze, Edward Higbee
William Morrow & Company
New York, NY 1960
Lib. of Cong. #60-14496
(U.S. Dept. of Agriculture)

FIGURE 3.1

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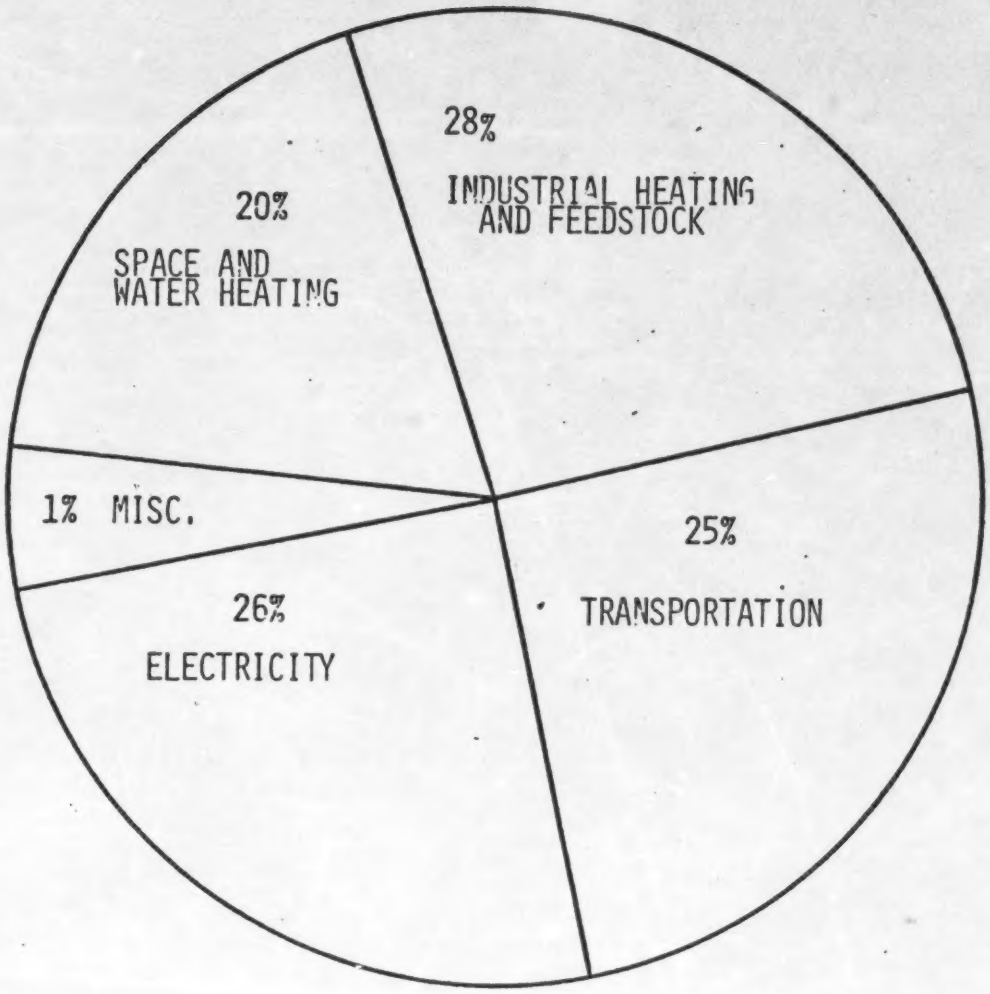
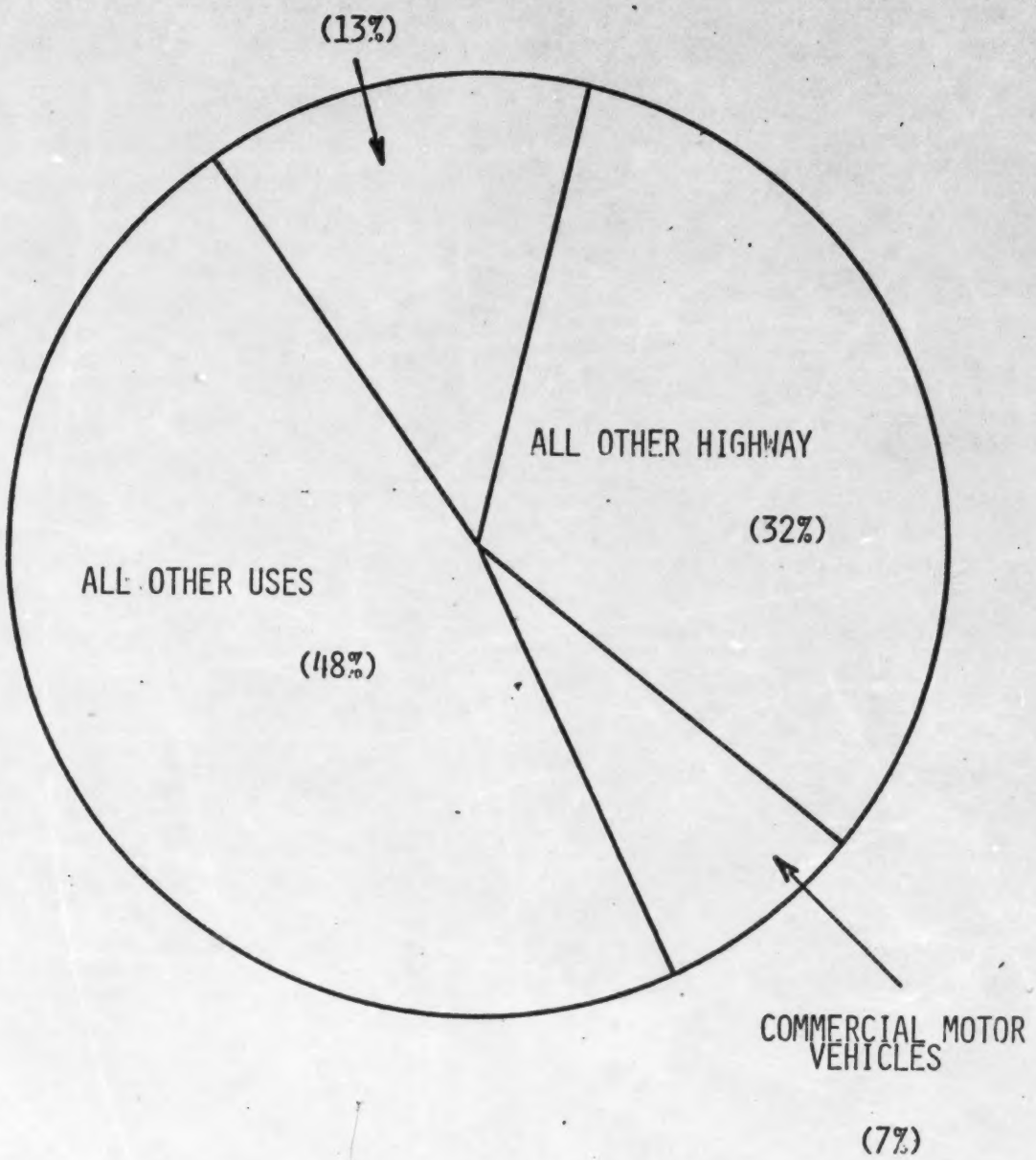


DISTRIBUTION OF ENERGY USE

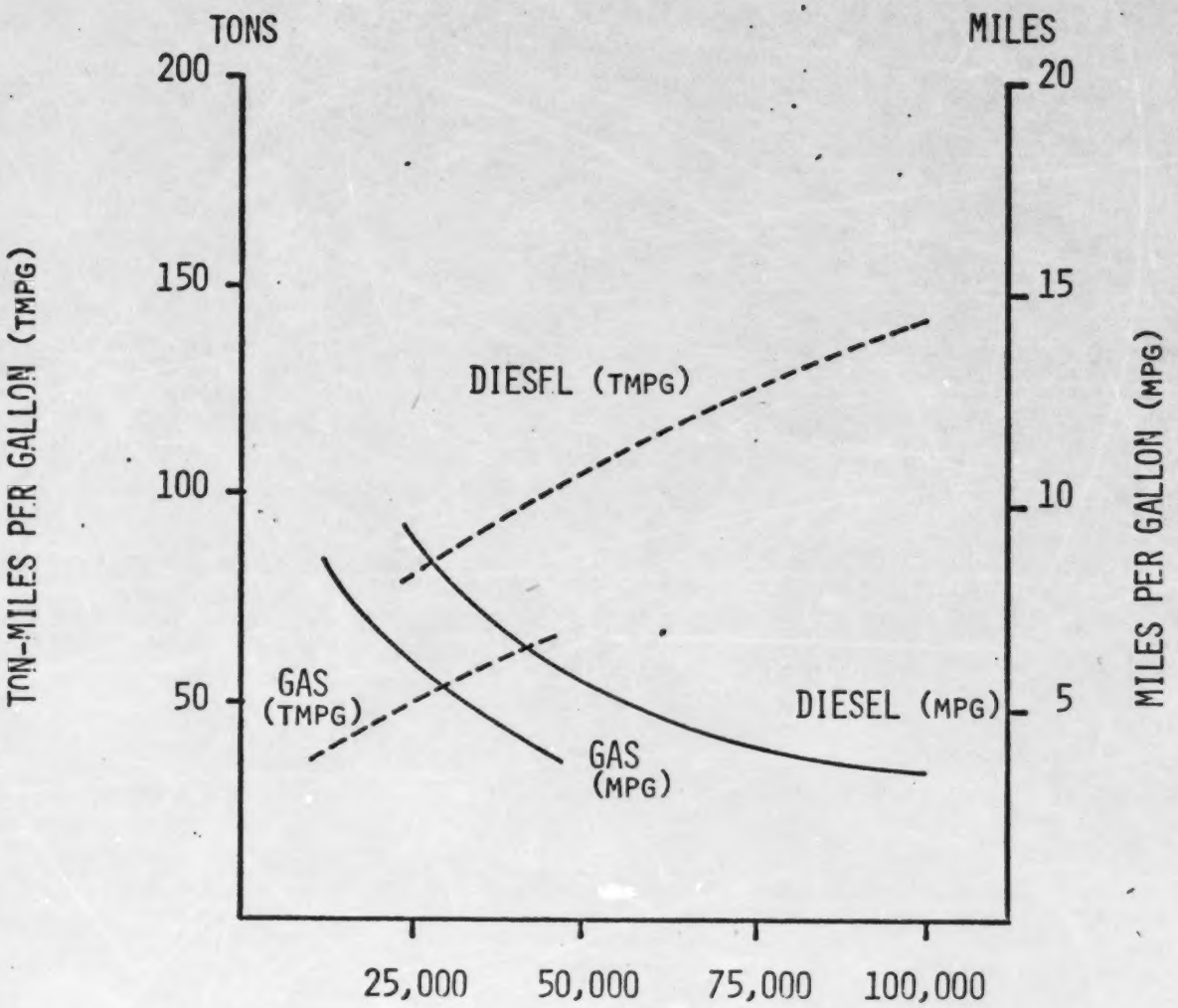
FIGURE 4.1



TOTAL U.S. PETROLEUM CONSUMPTION - 1973

FIGURE 4.2

APPROXIMATE PRODUCTIVITY IN TON-MILES PER GALLON
VS. FUEL ECONOMY IN MILES PER GALLON



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A TON MILER PER GALLON IS THE NUMBER OF TONS THAT CAN BE HAULED ONE MILE ON A GALLON OF FUEL.

FIGURE 4.3